Development of the Intelligent System for Estimating the Parameters of Ocean Internal Wave

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***Abstract*-For forecasting parameters of the ocean internal wave from the geometric corrected MODIS remote sensing images, an intelligent system had been developed. The intelligent system was based on the MODIS remote sensing image with the latitude and longitude information. The MODIS remote sensing images were corrected by ENVI. The intelligent system was developed by the authoring tool of Multimedia ToolBook (MTB). The user could drag and place the magic point in any position of the remote sensing image. The coordinate values of the magic point could be read in the fields in intelligent system. For developing the intelligent system, many methods had been studied. The methods include the angle bisector method, geometrical center method, linear fitting method, determining the circle center by three points, and analog displaying technique. They show quickly and accurately the internal wave parameters in the intelligent system after the magic point is dragged all characteristic points. These characteristic points were in the feature lines, DongSha Atoll, and the crest of the ocean internal wave. The results show that the intelligent system developed by MTB could be used for forecasting parameters of the ocean internal wave such as the propagation direction, the maximum length of the crests, the distance from the DongSha Atoll, and the spacing of the crests.**

Keywords- Intelligent System ; Drag Method ; MODIS

I. INTRODUCTION

The ocean internal waves compose a great threat to ships, submarines, and oil drilling platforms. The ocean internal waves were caused by the surface water gravity of the moon and the sun, atmospheric wind, the movement of the ships or submarines [1-4]. In 1847, Stokes carried on a research on the interface wave theory of two layer fluid. In 1883, Rayleigh explored the internal wave theory for the continuously stratified fluid. In 1895, Korteng and Devries raised the KdV theory. In 1904, the drift theory was put forward by Ekman and to explain the backwater phenomenon. The cause was the energy consumption in two layer interface and the internal waves generated in the interface. When the speed of the ship slowed, the phenomenon of resistance increasingly appeared. The universal ocean spectrum model of GM72, GM75, and GM79 had been built by Garrett and Munk. At present, the remote sensing method [3-4] is a very important research method for estimating parameters of the ocean internal wave. Jiang et al [5-7] had studied the method for estimating parameters of the ocean internal wave. The intelligent systems had been developed by MTB for extraction parameters of ocean internal wave. The parameters included the propagation direction, the maximum length of the crests, and the spacing of the crests. The intelligent system in this paper focused on forecasting the distance and the direction from the DongSha Atoll based on the geometric corrected MODIS remote sensing image.

II. GEOMETRIC CORRECTING

A. *Browsing the MODIS Remote Sensing Image*

The way for browsing the MODIS remote sensing image [7] was "The program / RSI ENVI4.0 / ENVI", "File / Open External File / Generic Formats / HDF", and "MOA_201107030525_1B_QKM. HDF". The MODIS remote sensing image was shown in Figure 1. There are three points that are obvious in the original image. The Taiwan Island was elongated. There were a large number of stripes alternating light and dark near DongSha Atoll. The most important point was there were periodic scanning traces and the space of two adjacent feature lines was 40 pixels as shown in Figure 2. The real distance could be calculated by the resolution of the MODIS remote sensing image was 250m and the real distance was 10km.

B. *Geometric Correcting*

The MODIS remote sensing image need to be geometric corrected and the method of the geometric corrected according to the method in Reference [7]. The geometric corrected image was shown in Figure 3. The enlarged and intercepted image in solar flaring was shown in Figure 4. The size of the intercepted image was 4 times as the corrected image with the average values intercepting adjacent two rows and two columns.

III. DEVELOPMENT OF INTELLIGENT SYSTEM

The interface design in authoring tool of MTB was the same as Reference [6] for development the intelligent system. The important step was to make the magic point. There were two aspects. One of the magic points could be dragged by the user. The second one was that the coordinate values of the magic point *x, y* could be read when the user clicked the fields. It could judge the numbers of the read data and estimated the parameters of the ocean internal waves in the intelligent system. It showed the parameters and the curves in the interface. The parameters included the propagation direction, the maximum length of the crests, and the spacing of the crests. The intelligent system in this paper was focused on forecasting the distance and the direction from the DongSha Atoll based on the geometric corrected MODIS remote sensing images.

The important point in the paper was forecasting the parameters of the ocean internal waves near China mainland.

There were four steps for estimating the distance and the azimuth relative to DongSha Atoll.

First, the number n_a of the characteristic points in DongSha Atoll had been decided with the intelligent system. The DongSha Atoll was an approximate circle [8]. The center and the radius were decided by three-point-method. The coordinate values *x*, *y* of the characteristic points could be read when the user dragged the magic point over any characteristic point and clicked the fields in the interface.

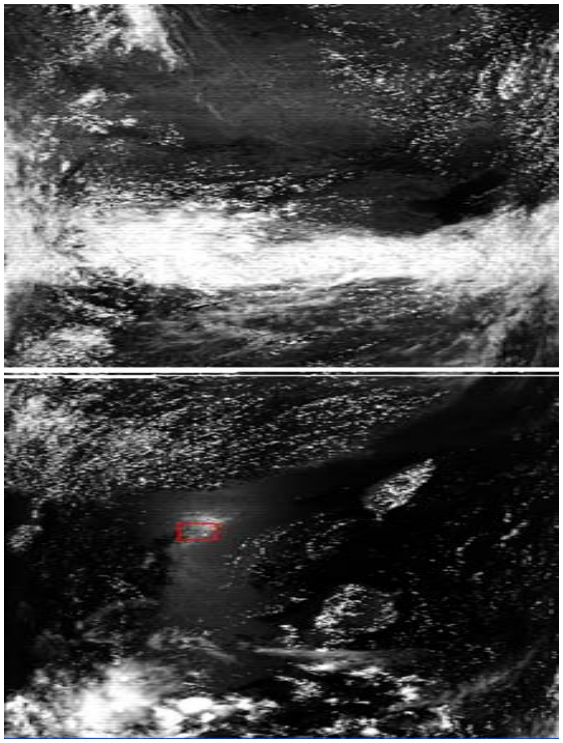

Figure 1 Remote sensing image

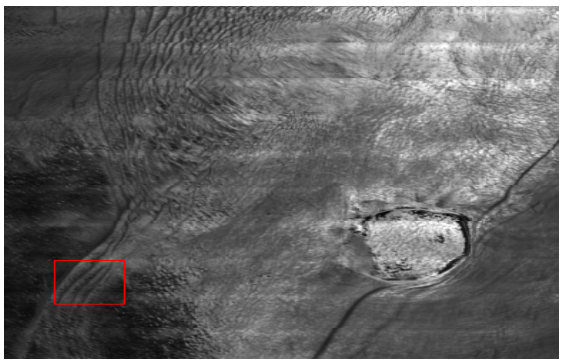

Figure 2 Ocean internal wave

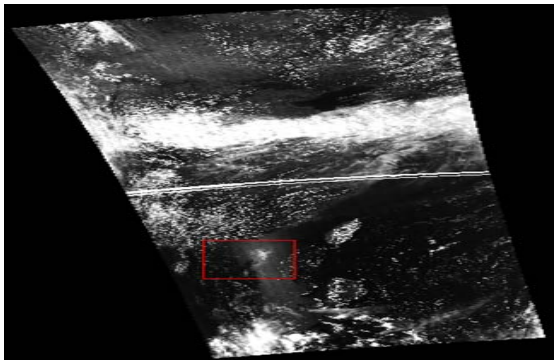

Figure 3 Geometric corrected image

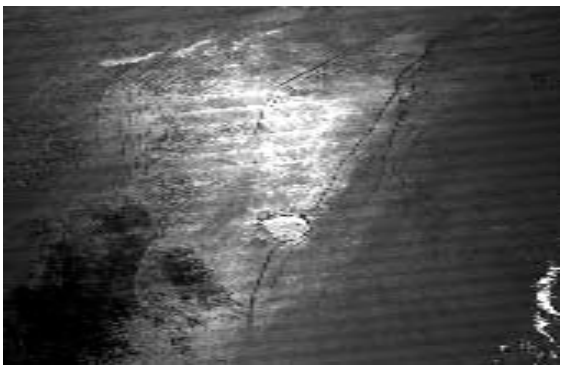

Figure 4 Enlarged and intercepted image

Second, the numbers of the two adjacent scanning feature lines in remote sensing image had been decided with the intelligent system. The distance was 10km and it was decided with the angle bisector method, geometrical center method, and linear fitting method.

Third, the line numbers N_b of the ocean internal waves had been decided with the intelligent system. The numbers of the characteristic points in any feature line of the ocean internal waves were noted as $n[i]$. For estimating the average distance between the lines of the ocean internal wave many methods had been used. The methods included angle bisector method, geometrical center method, and linear fitting method. At the same time the propagation direction of the ocean internal waves had been obtained based on the average slope.

Fourth, the distance from the ocean internal waves to DongSha Atoll was decided based on the two center points of the ocean internal waves and DongSha Atoll. At the same time the propagation direction of the ocean internal waves relative to DongSha Atoll had been obtained based on the two center points.

The flowchart of the intelligent system was shown in Figure 5.

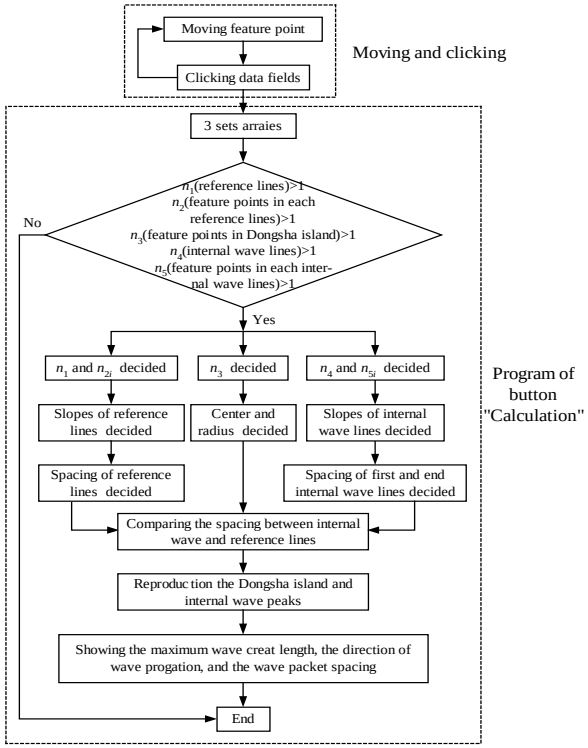

Fig. 5 The flow chart of the intelligent software

IV. CONCLUSION

The longest crest of the ocean internal waves could be obtained quickly and directly when the user clicked the button "Calculation" [5-7]. The distance from the ocean internal waves to Dongsha Atoll was obtained for the MODIS remote sensing image. The distance was 121km for the MODIS remote sensing image on July 3, 2011, 13:25 (Beijing time). The propagation direction of the ocean internal waves was North West 60.5 degrees relative to Dongsha Atoll. The space of the ocean internal waves was 4km as shown in Figure 6. The intelligent system was developed by the tool of MTB which was suitable for forecasting parameters of the ocean internal wave from the geometric corrected MODIS remote sensing images.

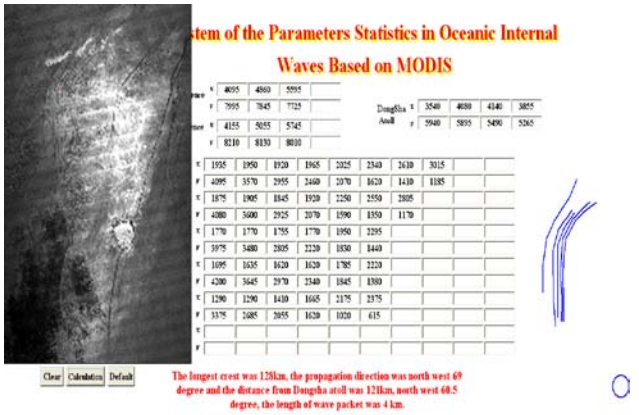

Figure 6 Interface of the intelligent system

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